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## THE PERIODICAL CICADA, BROOD XIV\*

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Probably no insect in North America attracts more attention or excites more curiosity than does the 17-year locust, or periodical cicada (Magi-cicada septendecim (L.)), and no other insect has been the subject of more general misinformation. With each recurrent visit of the periodical cicada, we read of "the plague of Egypt" descending upon us, but this insect is in no way related to the insect that visited Egypt in Biblical times and, for that matter, still visits that country and many other parts of the world. The migratory locusts are grasshoppers; the periodical cicada is not even distantly related to grasshoppers. The periodical cicada belongs to the Homoptera, a group of insects that feed by sucking their food. They cannot chew. Grasshoppers, on the other hand, have powerful mandibles with which they chew their food. The cicada cannot sting, and stories of poisoning of fruit in this manner are mythical. The confusion of this insect with the locusts of Egypt probably arose when a brood was first observed by the colonists at Plymouth, Mass. These people from England were not familiar with plagues of locusts, such as occur in the Mediterranean region, but they were familiar with the Biblical stories, and when vast numbers of cicadas emerged in 1634 the colonists probably thought "the plague of Egypt" had been sent by act of God. The Indians knew the insect before the advent of the white man, and attached a baleful significance to its periodic appearance.

The periodical cicada is a close relative of the harvest flies, which sing during the hot days of midsummer, but it is a smaller insect, being only 1-5/8 inches long, including the wings. The greater part of its

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\*The introductory part of this circular is drawn largely from E-364.

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body is black, and it has red eyes. The legs and the margins of the principal veins in the four nearly transparent wings are bright orange colored, and near the outer end of the front wings is a very distinct black letter "W" produced by deeper pigmentation of the veins. This is a constant characteristic of this species and does not appear as an omen of war, as is generally believed by the superstitious. A smaller form of this cicada, measuring about 1-3/8 inches in length, has been recognized as a variety and has been named cassinii. The periodical cicada appears much earlier in the season than do the ordinary harvest flies, is much more numerous, and occurs over a much shorter period. It is the sudden appearance of enormous numbers of this insect after long intervals that occasions alarm.

### Historical Review

The earliest known publication (1) mentioning the species appeared in 1666, and several accounts were published before 1750. One (2) refers to an appearance at Plymouth, Mass., in 1634. The early writers noted the unusual visitations of large numbers of the insects, their emergence holes, the noise made by them, and the damage done to the trees in oviposition. Writers from 1750 to 1775 knew of the periodic appearance and inferred the length of the period to be about 17 years. Later writers were more certain about the period. Linnaeus (3) described the species in 1758 from specimens from America.

Nathaniel Potter of Baltimore studied the species for over 50 years, and in an article (4) written in 1834 he defined some important 17-year broods. G. B. Smith, working between 1830 and 1870, was able to determine the time and approximate territory of most of the important broods. He, and D. L. Phares of Mississippi, discovered the 13-year life period in the South. C. V. Riley began work about 1868 and vigorously carried on observations and correspondence, which added greatly to available knowledge of the broods. He numbered the broods more accurately than had been done before. Later C. L. Marlatt (5) extended this work, mapped the area covered by the broods, and devised the present clear-cut system of numbering them. He also studied the life history and habits very carefully. Numerous other workers have aided in giving information as to structure, habits, and distribution. At present the Division of Insect Pest Survey and Information of the United States Department of Agriculture is carrying on this work, with the help of Federal and State entomologists.

### Life History

Periodical cicadas appear suddenly during the last week of May in the Northern States and during the last week of April or the first week of May in the South. The ground over limited areas is riddled with emergence holes from which the awkward, crayfishlike pupae emerge. Emergence usually takes place in the night, and in the morning vast numbers of empty pupal cases are found on the tree trunks, twigs, leaves, and almost every available support. Shortly after the pupae emerge from the ground, the pupal

case splits along the middle of the back and the adult works itself out. When the adult first emerges it is a small, bizarre-looking animal, being milky-white with bright red eyes; it soon hardens, however, and assumes more somber coloring. The males emerge first, often several days before the females. They also disappear first, and late in the season only females can be found. About the first of July the insects become very scarce, and by the second week in July practically all of them are gone. Shortly after the cicadas emerge the woods resound with the incessant singing of the males, which alone have sound-producing apparatus. We quote Snodgrass (6), who has described the singing as follows: "During the first two weeks of June the woods were full of the 'locusts' and the noise of their singing. The song has no resemblance whatever to the shrill, undulating screech of the annual locusts so common in August and September and known as the dog-day cicadas. The song and all the notes of the larger variety of the 17-year cicada are characterized by a burr sound and at least four different utterances may be distinguished. First, there is the prolonged burring sound of their ordinary song, the individual notes of which become lost in the continuous hum of the multitude, and I never heard one singing this song in solo. Next there is the so-called 'Pharaoh' note, which requires some imagination to interpret it thus, for it is characterized by the same burr tone as the chorus song. The Pharaoh sound is usually sustained only about 5 seconds, when it terminates with an abrupt falling. Then it is repeated indefinitely at intervals of 2 to 5 seconds. When each note is begun the singer lifts his abdomen to a rigid, horizontal position, evidently thus opening the ventral drum chambers. As the sound ends the abdomen drops again to the usual somewhat sagging position, seemingly thus cutting off the sound by closing the drums; but, of course, the two are coincidental, since the sound terminates when the tympanal muscles cease to vibrate. The males are easily observed uttering the Pharaoh song as they sit in the bushes or on low branches of the trees, but the community singing is always done in the tops of the trees, where I never observed an individual musician at close range while performing.

"Their third note is a soft purring sound of one syllable, which is often heard from those sitting low in the bushes. It is shorter than the Pharaoh sound and lacks the abrupt terminal drop. Finally, when a male appears to be surprised or frightened, he often, as he darts away, utters a loud, rough burr sound. They utter the same note when picked up or otherwise handled. This seems to be their note of 'primitive passion,' and if so is perhaps the one from which the more melodious ones have been developed.

"The smaller form, variety, or species, the one called 'cassinii,' differs from the larger form in the character of its notes always, if in no other way. The regular song of the little males much more resembles that of the annual summer cicadas, though not so long and less continuous in tone. It commences with a few chirps, then there follows a series of strong, shrill sounds like zwing, zwing, zwing, etc., ending again in a number of chirps. The whole song lasts about 15 seconds. Several of these males kept in jars sang this song repeatedly and sang no other. It was common out of doors, but always heard as a solo, never in chorus."

About a week or 10 days after emerging, the insects mate and a few days later the females begin laying eggs. The eggs are laid in twigs and small branches of a wide variety of plants. Seventy or eighty different



species of trees, shrubs, and herbaceous plants have been listed as harboring the eggs of this insect. The females seem to have a decided preference, however, for oak, hickory, and apple, while peach, pear, and grape are sometimes severely damaged by the egg laying. Twigs in which many egg pockets are made are often broken off or partly broken from the tree, and these broken twigs with their masses of browned leaves are characteristic appearances in the woodlands and orchards late in the summer of a cicada year. The female deposits the eggs in the twigs by means of a sawlike apparatus at the end of the abdomen. With this apparatus she makes a pair of pockets near the surface of the twig and deposits 2 rows of eggs—about 24 to 28 eggs altogether—in each pair of pockets. She then moves forward, makes another pair of pockets, and continues until from 5 to 20 of these twin pockets are placed close together in straight rows. In one instance 50 pockets were observed on 1 twig. Sometimes these pockets are so close together as to form a continuous slit from 2 to 3 inches long in the twig. A single female will make several rows of such pockets on different twigs, and will during her lifetime deposit from 400 to 600 eggs. The eggs remain in the twigs from 6 to 7 weeks before hatching and during this time they are said to absorb plant juice and become larger. If the twig is killed before the eggs are matured they will not hatch. Eggs normally start hatching in mid-July and continue hatching into the early part of August. According to Snodgrass, the first sign of egg hatching is the little heap of shriveled skins at the entrance hole of the egg nest. The eggs nearest the entrance of the chamber hatch first, and the young nymph, still enclosed in the embryonic membrane, wriggles out of the opening. It immediately sheds the membrane and runs about, first in the groove of the twig containing the egg nest, then out on the smooth bark, from which it falls to the earth. After the first eggs hatch the others hatch rapidly. Possibly the stimulus to hatching is the release of pressure. When the larva emerges from the egg shell it soon falls to the ground, burrows down until it finds a suitable rootlet, and there, inserting its mouth parts, starts again the long period of underground existence of this remarkable insect.

Four larval instars have been recognized; that is, the insect molts three times before transforming to the so-called pupal stages, of which there are two. The larvae usually live in the soil at depths of from 18 to 24 inches. There are questionable records, however, of larvae having been found 5 feet below the soil surface. About the middle of April the pupae burrow up to within an inch or less of the surface, where they construct more or less perpendicular tunnels, in which they remain until time for emergence. In excavating these tunnels the loosened earth is pressed into the side walls, thus obviating the necessity for opening the burrows to the surface. The tunnels are from 1 to 6 inches long and  $\frac{5}{8}$  inch in diameter in the shaft, with a slight enlargement at the base and immediately below the constricted exit.

The pupa sometimes constructs a peculiar chimney of little pellets of mud closely packed around a tube, in which it awaits the time for emergence. The chimney is capped and the pupa tears an opening in the top when ready to emerge. The chimneys range from  $1\frac{1}{2}$  to 8 inches in height. They are more or less cylindrical, about 1 inch to  $1\frac{1}{4}$  inches in diameter, rapidly tapering to a rounded dome at the end, with a cylindrical passage the same size as the burrow in the ground.

## Factors Reducing Cicada Numbers

Many cicadas fail to pass successfully through the vicissitudes of the life cycle. A few die while trying to molt to adults, and many apparently fail to hatch or to get established on roots; however, enough succeed to maintain vast numbers.

The periodical cicada has many natural enemies, among which insects play minor roles. Insects attacking the adult periodical cicada cannot be specific enemies adapted to its long cycle, but must be those that depend on other hosts and attack the periodical cicada incidentally when it is present. A number of insects and mites are known to attack adults and eggs. A fungous disease is known to attack adults, but is not thought to be important in reducing their numbers. Many vertebrates, as birds, poultry, fish, dogs, hogs, and squirrels, have been recorded as feeding on the adult cicadas. Hogs pastured in the woods are known to root out and destroy practically all the mature nymphs in their final burrows near the surface, but they probably cannot reach many of the growing nymphs on the roots. Moles possibly get some of the mature nymphs. Birds are serious enemies of the cicada. Where cicadas are numerous and birds rather few, as in dense woods, the birds will not materially reduce cicada numbers, but where the situation is reversed, as in small open groves or near houses, the cicadas may be greatly reduced or wiped out.

The changes brought about by man have caused a great reduction in the numbers of the periodical cicada. Through clearing much of the forest a large part of the cicada's habitat has been destroyed, and by opening up much of the timber left standing, its enemies have been given a better chance to attack it. However, the species still shows a capacity to maintain itself where its environment is not too much altered, and it persists in many spots throughout its old range.

## Injury Caused by the Cicada

It has been noted that the feeding of adults and nymphs apparently causes no perceptible harm to plants but that the egg punctures made by the females sometimes cause twigs to wilt. Twig injury is not serious to forest trees but is sometimes injurious to fruit trees in recently cleared land, where cicadas emerge from the soil, and in orchards bordering infested woods. In extreme cases small trees just set out in such places may be severely injured or even killed and larger trees may have many twigs killed or scarred. It is better not to plant fruit trees in these exposed locations the year that periodical cicadas are expected. As to large trees, if little or no pruning is done the preceding winter, much of the injured wood may be removed the following winter with little harm. The wounds, however, give ingress to diseases and serve as shelters for scale insects, woolly aphids, and other insects.

## Broods

The 17-year or 13-year period is followed quite regularly by each brood, therefore its recurrence can be predicted with confidence. As a few



adults are sometimes seen a year before or a year after a large brood has appeared, it seems likely that a very small proportion of the brood may mature a year early or a year late. These irregular individuals are few, however, and are probably destroyed by birds. Our important broods are known to have appeared at regular intervals for long periods, in one instance for over 200 years.

Most broods are limited to fairly definite areas, within which they generally occupy nearly all favorable locations, but there are some exceptions. Scattered colonies or swarms not closely connected with these large regional broods occur, in some cases near the edge of the broods, in others remote from them. Brood II, appearing in 1911 and 1928, for example, covers a definite region along the Atlantic coast, but a colony in north-central Oklahoma has also appeared in these years. The Oklahoma colony must be listed with this brood, although unconnected with it. Close observers have given us some records of the appearance of a few individuals at unexpected times and places. Most individuals, however, occur in the compact regional broods, and it is only these that the ordinary observer is likely to notice.

Broods vary considerably as to area covered, regularity of boundaries, and scattering, or density. Nearly all of the brood that appeared in 1931 was in one rounded area and a number of others were almost as compact. Other broods cover more irregular areas that may be divided or that have outlying parts. The brood that appeared in 1932 was especially widespread and scattering, having only small and scattered colonies over a large part of its range. Sometimes broods overlap, so that more than one brood may occur in a locality. Careful students of the subject have gradually worked out and mapped the area occupied by each brood. The southern area of the 13-year life cycle is rather sharply set off from the 17-year area, although there is some overlapping.

For numbering the broods we use the system originated by C. L. Marlatt. The 17-year brood that appeared in 1893 he designated as Brood I, that of 1894 as Brood II, and so on, allowing a Roman numeral for each year of the 17 possible brood years. The records for 1909 were placed as Brood XVII; in 1910 Brood I emerged again. The system goes on to number all possible 13-year broods, from XVIII to XXX. The records for 1893 were placed under Brood XVIII, the brood emerging in 1894 was numbered XIX, and so on. Of the 17 possible 17-year broods, we know of 13 that occupy definite areas, large or small. For the remaining 4 broods we have only scattered records. The 13-year broods are much fewer than the 17-year broods. There are 2 large and important broods and 2 or 3 others which are rather definite, though more local; for the other years we have only scattered records or none at all. The origin and relation of these broods has engaged the interest of many able students.

Originally the broods by random variation were probably evenly distributed throughout the entire range of the insect, this resulting in a more or less continuous appearance annually of individuals in all locations and no distinguishable periodicity of broods. This insect was undoubtedly one of comparatively long nymphal life. From the northernmost limits of

its range, it, in all probability, reached the maximum length of larval life, progressively shortening its period as it occurred southward. The fact that certain years were more favorable than others probably tended to increase the number of individuals in those years until distinct broods, though surrounded and obscured by less distinct broods, became established. A catastrophe, such as a forest fire, any time between the latter part of May and the middle of July, would wipe out all individuals in that year over the area of the catastrophe. This would give the initial impulse to periodicity of broods in that region. Ages of such catastrophes, occurring first over one area, then over another, would produce exactly the phenomenon that we now see. The insect still exhibits the tendency to vary in length of the larval period, but the chance of any accelerant or retardant ever establishing a new brood, except after another catastrophe, is reduced to the improbable. Those that emerge are promptly destroyed by natural predators. This occurred in Washington, D. C., in 1906, when the transplanted colony established there in 1889 was exterminated by birds.

#### References Cited

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- (2) 1669. Moreton, N. New England's Memoriall. 214 pp. Cambridge.
- (3) 1758. Linnaeus, C. Systema Naturae 1:436.
- (4) 1839. Potter, N. Notes on the *Locusta septentrionalis americanae* decim septima. 27 pp., illus. Baltimore.
- (5) 1907. Marlatt, C. L. The Periodical Cicada. U. S. Dept. Agr., Bur. Ent. Bul. 71. 181 pp., illus.
- (6) 1921. Snodgrass, R. E. Smithsn. Inst. Ann. Rept. 1919: 396-397.

## BROOD XIV

Brood XIV of the periodical cicada, scheduled to appear in 1940, is a scattered brood covering a wide range of territory extending from Massachusetts westward to Illinois and southward to northern Alabama. The principal area inhabited by this brood is the Ohio River Valley down to Louisville, Ky., and the Appalachian Mountains. This is evidently the brood observed by the colonists at Plymouth, Mass., in 1634. The records of occurrence of the insect in the years of this brood have been compiled. Many of them are old and questionable. It is hoped that records this year will enable us to map definitely the distribution of the brood.

### Georgia.

Gilmer 1855; Gordon, Calhoun 1855, 1872; Habersham, Cornelia 1906; Pickens 1855; Rabun; Towns; Union; White.

### Illinois.

Boone; Greene 1906; Grundy 1906; Henry, Cambridge 1889; Jo Daviess, Stockton 1906; Johnson 1906; Lake; McHenry, Crystal Lake 1872; McLean; Putnam, Putnam 1889; Stephenson; Vermilion, Indianola 1906; White-side, Morrison 1906; Winnebago; Woodford, Minonk 1906.

### Indiana.

Boone, Lebanon 1906; Brown 1889, Nashville 1906; Carroll, Delphi 1906; Clark 1889; Clay 1889, 1872; Crawford 1872, 1889; Daviess 1889; Dearborn 1889, 1906; Dubois 1889, 1906; Floyd 1889, 1906; Fountain, Silverwood 1906; Franklin, Brookville 1889; Gibson 1889; Grant (southeastern part) 1889, 1906; Greene 1889, Worthington 1872; Harrison 1889, 1906, Corydon 1923, Corydon Junction 1923, Laconia 1923; Jackson, Brownstown 1906; Johnson 1906, Franklin 1889; Knox, Bicknell 1872, 1906, Vincennes 1889, 1906; Lake 1872; Lawrence 1889, 1906; Monroe 1889, 1906; Morgan 1889, 1906; Orange 1889, 1906; Perry, Dexter 1906; Pike 1889; Posey 1889, New Harmony 1872; Putnam 1906, Greencastle 1889; Ripley, Holton 1906; Scott 1889, 1906; Steuben, Hamilton 1906; Sullivan 1889, Dugger 1906, Sullivan 1906; Switzerland 1889; Tippecanoe 1889, 1906, La Fayette 1923; Vanderburgh, Inglesfield 1889; Vigo 1889; Warrick 1889, 1906; Washington 1889, 1906; Wayne, Richmond 1906.

### Kentucky.

Adair 1855, 1872, 1906, Craycraft 1889; Allen 1838, 1855, 1872, Holland 1889, Scottsville 1906; Anderson, Lawrenceburg 1855, 1872, 1889, 1906; Ballard, Bandana 1906; Barren 1872, 1889, Dryfork 1906, Glasgow 1906, Hiseville 1855; Bath, Moores Ferry 1855, 1872, 1889, 1906, Owingsville 1889; Bell 1906; Bourbon; Boyd 1889, Catlettsburg 1906, Culbertson 1906, Naples 1906; Boyle, Perryville 1906; Breckinridge 1906, Hardinsburg 1872; Bracken 1906; Breathitt 1906; Bullitt 1889, Brooks 1906, Clermont 1906; Butler 1906; Campbell 1906; Carlisle, Bardwell 1906; Carroll 1906; Carter 1889, Grayson C. H. 1906; Casey,



Bethelridge 1889, 1906, Kidds Store 1872, 1889; Clark, Winchester 1855, 1872, 1906; Clay 1906; Clinton 1872, 1906; Cumberland, Marrowbone 1889, 1906, Peytonsburg 1872, 1889; Edmonson 1889, 1906; Estill, Witt 1906; Fayette, Lexington 1855, 1872, 1889; Fleming, Flemingsburg 1855; Floyd, Lane 1906; Franklin 1906, Frankfort 1855; Gallatin 1906; Garrard 1906; Grant 1906; Grayton, Falls of Rough 1906, Short Creek 1906; Green 1906; Greenup 1906, Russell 1889; Hancock 1906; Hardin 1838, 1855, 1872, 1889, Elizabethtown 1906, Nolin 1906, Saint John 1906; Harlan 1906; Harrison 1906; Hart 1855, 1872, 1889, 1906; Henry, Franklinton 1906, Pendleton 1906; Jackson 1872, 1906; Jefferson 1906, O'Bannon 1872, 1889; Jessamine, Logana 1906; Johnson, Flatgap 1889, 1906, Volga 1906; Knott 1872, 1906; Knox 1855, 1872, 1889, Emanuel 1906; Larue, Buffalo 1906, Hodgenville 1923; Laurel, Pittsburg 1872, 1906, London 1906; Lawrence, Vessie 1906; Lee, Delvinta 1906; Leslie 1906; Letcher 1906; Lewis 1889, 1906; Lincoln, Hustonville 1906, Maywood 1906, Stanford 1855, 1872, 1889, 1906, Waynesburg 1889; Logan, Homer 1906, Oakville, 1889; McLean 1855; Madison 1906, Panola 1889, Richmond 1872, White Hall 1889; Magoffin, eastern part 1872, Sublett 1906; Marion, Lebanon 1889, 1906; Martin, 1855, 1872, 1889, 1906; Mason 1855, Helena 1906, Maysville 1872; Meade 1906; Menifee, Scranton 1906; Mercer 1872, 1906; Metcalfe 1906, Center 1872; Monroe, Cyclone 1906; Montgomery 1821, 1838, 1855, 1872; Morgan 1906, Blaze 1889, 1906; Nelson, Bloomfield 1906, 1923, Fairfield 1906, Deatsville, 1855, 1872, 1889, Trappist 1906; Nicholas 1889, 1906; Oldham 1906, Goshen 1889; Owen 1855, 1872, 1889, 1906; Owsley, Booneville 1838, 1855, 1872, 1889, 1906, Buck Creek 1906, Southfork 1872, Sturgeon 1906; Pendleton 1906; Perry 1889, 1906; Pike, Canada 1889, 1906, Fishtrap 1906; Powell 1906, Clay City 1855, 1872, 1889; Pulaski, Dabney 1855, 1872, 1889, 1906, Eubank 1889, Pulaski 1889; Rockcastle 1889, 1906, Mount Vernon 1838, 1855, 1872; Rowan 1889, Morehead 1906; Russell 1906, Jamestown 1855, 1872; Scott 1906; Shelby 1872, 1906 (southern part); Simpson, Gold City 1906; Taylor, Bengal 1906, Campbellsville 1906, Mannsville 1906; Trigg, Canton 1889; Trimble, Bedford 1872; Union, Henshaw 1889; Warren, Bowling Green 1906, Smiths Grove 1838, 1855, 1872, 1889, 1906, Woodburn 1889; Washington 1906; Wayne, Hidalgo 1906, Rankin 1872; Whitley 1838, 1855, 1872, Meadorsville 1906, Woodbine 1889; Woodford 1906.

## Maryland.

Allegany 1906; Anne Arundel 1889; Baltimore, Rayville 1889; Frederick, Frederick 1906, Walkersville 1906; Garrett, Friendsville 1889; Howard, Elkridge 1923, Ellicott City 1906; Montgomery, along Conduit Road 1906, Silver Spring 1923, Washington Grove 1906; Prince Georges, College Park 1906; Washington 1889, Boonsboro 1906, Keedysville 1906, Mapleville 1906, Ringgold 1923.  
District of Columbia, 1889, 1906.

Barnstable 1770, 1787, 1804, 1821, 1838, 1855, Barnstable 1872, 1906, 1923, Bourne 1906, 1923, Buzzards Bay 1906, Dennis 1906, Falmouth 1872, 1889, 1906, 1923, Mashpee 1906, 1923, Monument Beach 1923, North Falmouth 1906, Pocasset 1923, Sagamore 1923, Sandwich 1787, 1804, 1821, 1872, 1906, 1923, Waquoit 1923, Wianno 1906, Yarmouth 1872, 1906, 1923; Plymouth, Chiltonville 1906, Plymouth 1634, 1804, 1838, 1855, 1872, 1906, 1923, Wareham 1906, 1923.

## New Jersey.

Bergen, Englewood 1889, Hackensack 1906; Burlington, Palmyra 1889; Cape May; Monmouth, Red Bank 1889; Mercer, Princeton 1889, Trenton 1889.

## New York.

Nassau, East Norwich 1906, Farmingdale 1906, Hicksville 1906, Oyster Bay 1906, Sea Cliff 1923, Syosset 1906; Richmond 1923, Richmond Valley 1906; Suffolk, Brentwood 1889, 1906, Calverton 1889, 1923, Center Moriches 1906, Central Islip 1906, Cold Spring Harbor 1906, 1923, Coran 1906, 1923, Commack 1906, East Moriches 1906, Eastport 1906, 1923, Greenlawn 1906, 1923, Huntington 1906, 1923, Islip 1906, Laurelton 1906, Manorville 1906, 1923, Moriches 1906, 1923, Nesconset 1923, Port Jefferson 1906, 1923, Peconic 1906, Quogue 1923, Saint James 1906, 1923, Selden 1923, Wading River 1906, 1923, Westhampton 1889.

## North Carolina.

Buncombe 1855, 1906, 1923 (northern part), Asheville 1872, 1889, 1906, Biltmore 1906, Black Mountain 1889, 1906, Candler 1906; Caldwell 1906, Blackstone 1906, Kings Creek 1906, Lenoir 1889, 1906, Patterson 1889, Yadkin Valley 1855, 1872, 1889, 1906; Caswell, Milton 1906; Granville, Oxford 1906; Haywood, Clyde 1906, Waynesville 1855, 1872, 1889, 1906; Jackson 1906, Willets 1906; Madison 1872, 1906, 1923, Mars Hill 1906, Stackhouse 1906; McDowell 1855, 1906, 1923, Ashford 1889, 1906, Greenlee 1889, Old Fort 1889, 1906; Mitchell 1855, 1872, 1889, Hawk 1906; Watauga 1906, Sands 1906; Wilkes 1906, Mount Zion 1889, Wilkesboro 1889, 1906; Yancey, Bald Creek 1906.

## Ohio.

Adams 1821, 1838, 1855, 1872, 1889, 1906, 1923, Beaverpond 1889, Harshasville 1906, Manchester 1923, Mineral Springs 1889, Peebles 1923, Seaman 1906, West Union 1906, 1923, Winchester 1923; Auglaize, Wapakoneta 1906; Brown 1804, 1821, 1838, Franklin Township 1906, Georgetown 1855, 1872, 1889, 1906, 1923, Hamersville 1923, Lewis Township 1906, 1923, Locustridge 1906, Mount Orab 1906, 1923, Ripley 1923, Sardinia 1906, 1923; Butler 1906, 1923, Gano 1872; Champaign, Mechanicsburg 1923; Clermont, Amelia 1889, 1906, Batavia Township 1923, Bethel 1906, Hennings Mill 1906, Loveland 1889, Marathon 1906, Milford 1906, New Richmond 1923, Newtonsville 1923, Nicholsville 1906, Owensville 1906, Stonelick Township 1923, Williamsburg



1906; Clinton, Adams Township 1923, Blanchester 1906, Chester Township 1923, Marion Township 1855, 1872, 1906, Melvin 1889, New Burlington 1923, New Vienna 1906, 1923, Union Township 1923, Wayne Township 1923, Wilmington 1906, 1923; Columbiana, Lisbon 1906; Delaware, Delaware 1906; Fayette, Concord Township 1906, Green Township 1906, Jeffersonville 1906, Perry Township 1906, 1923, Washington Courthouse 1872, 1906, Wayne Township 1906, 1923; Gallia 1889, 1906, 1923, Bidwell 1923, Clay Township, Sec. 4, 1923, Gallia 1906, Gallipolis 1821, 1923, Morgan Township 1923, Northrup 1923, Perry Township 1923, Raccon Island 1906, Rodney 1889, Thivener 1923, Thurman 1923, Vinton 1923; Greene, Caesar Creek Township 1923, Jamestown 1906, Spring Valley Township 1906, 1923, Xenia 1906, 1923, Yellow Springs 1889; Hamilton, Anderson Township 1923, Cincinnati 1872, 1889, Cleves 1872, Columbia Township 1906, 1923, Harrison 1906, Loveland 1906, Plainville 1906, Sycamore Township 1923, Symmes Township 1923; Highland 1872, Belfast 1923, Concord Township 1923, Greenfield 1906, 1923, Highland 1923, Hillsboro 1906, 1923, Jackson 1923, Leesburg 1906, Marshall 1906, Newmarket Township 1923, Paint Township 1923, Washington Township 1923, White Oak Township 1923; Jackson, Cove 1906; Lawrence, Athalia 1889, Hanging Rock 1906, Ironton 1906, 1923, Kitts Hill 1923, Mason Township 1906, North Kenova 1906, Proctorville 1923, Rock Camp 1906, 1923, Sherritts 1923, Wilgus 1906; Meigs 1906, Alfred 1923, Pomeroy 1923, Rutland 1872; Pike 1923, Camp 1906, Idaho 1906, Seal Township 1906, Waverley 1889; Preble, Israel Township 1906; Ross, Bainbridge 1906, Bourneville 1923, Buckskin Township 1923, Concord Township 1923, Chillicothe 1906, 1923, Frankfort 1872, 1923, Lyndon 1906, Roxabell 1906, 1923, Twin Township 1923; Scioto, Franklin Furnace 1906, Lucasville 1906, 1923, Otway 1906, 1923, Portsmouth 1906, 1923, Rarden 1923, Sciotoville 1906, Wheelersburg 1906, 1923; Vinton 1855, 1906, McArthur 1906, 1923; Warren 1906, Cozaddale 1889, Franklin 1923, Harlan Township 1906, 1923, Harveysburg 1906, Lebanon 1906, 1923, Middletown Junction 1923, Oregonia 1923, Pleasant Plain 1923, Turtle Creek Township 1923, Waynesville 1838, 1855, 1872, 1923; Washington, Bartlett 1923, Fleming 1923, Little Hocking 1906.

## Pennsylvania.

Southern Pennsylvania 1821, 1838, 1855; Adams 1872, 1889, Arendtsville 1923, Bendersville 1923, Biglerville 1923, Flora Dale 1923, Idaville 1923, Orrtanna 1923; Blair, Altoona 1889, Woodbury Township 1906, Terrace Mountain 1923; Bedford 1889, 1906; Berks, Bernville 1923, Mount Penn 1923, Reading 1906; Bucks 1906, Pleasant Valley 1923; Cameron, Driftwood 1872; Carbon, Pleasant Corners 1889; Centre, Fleming (in Bald Eagle Valley), 1821, 1838, 1855, 1872, 1889, Phillipsburg 1889, Snow Shoe 1889, State College 1872, 1889; Chester 1872, Compass 1923; Clearfield, Clearfield 1889, 1906, Curwensville 1906, Hawk Run 1923, Karthaus 1889, 1923, Lumber 1906, Munson 1923; Clinton 1855, 1872, 1889, 1906, Lock Haven 1906, 1923, Renova 1923; Columbia 1889; Cumberland, Camp Hill 1889, Carlisle 1906, Hatton 1889; Dauphin Inglenook 1923; Franklin 1872, Blackgap 1923, Chambersburg 1889,



Pen Mar 1906, 1923; Fulton, southern part 1889; Huntingdon 1889, Union Furnace 1923; Juniata 1889; Lancaster, Lancaster 1872, 1889, Marietta 1872; Lebanon, Millback 1906; Lehigh, Slatington 1906, Zionsville 1906; Luzerne, Fairmount Township 1906, Hazleton 1923, Kyttille 1906, Wilkes-Barre 1923; Lycoming 1889, Brady Township 1906, Marsh Hill 1923, Washington Township 1906, Williamsport 1889; Mifflin 1889; Montour, Danville 1906, 1923; Montgomery, Bryn Mawr 1923; Northumberland 1889, Delaware Township 1906, Milton 1923, Mount Carmel 1923, Paxinos 1906, Shamokin 1923, Sunbury 1821, 1906, 1923; Perry, Duncannon 1923, Elliptsburg 1923, Newport 1923; Potter 1906; Schuylkill, Sheppton 1906; Snyder 1889, Freeburg 1923, Middleburg 1906, Rolling Green Park 1923, Selinsgrove 1804; Tioga, Canoe Camp 1906; Union, Allenwood 1906, Buffalo Valley 1804, 1821, 1838, Lewisburg 1821, 1838, 1855, 1872, 1889, 1906, Mifflinburg 1906; York 1872, Conewago Township 1906, Dillsburg 1923, Hanover 1923, Hellam Township 1889.

## Tennessee.

Anderson 1906; Bledsoe 1906, Pikeville 1838, 1855, 1872; Blount 1906; Campbell, Jacksboro 1906, Jellico 1906; Cannon, Bradyville 1906; Carter, Fifth Civil District 1906; Cheatham, Pleasant View 1906; Claiborne, Tazewell 1872, 1906, Hoop 1906; Cocke, Newport 1906; Coffee, Tullahoma 1906; Cumberland 1855, 1872, 1889, Peavine 1906; Davidson (northern part) 1906; DeKalb 1838, 1855, 1872, 1889, Smithville 1906; Fentress 1872, 1889, Allardt 1906; Franklin, Winchester 1906; Grainger 1906, Tate Spring 1889; Greene 1906; Grundy 1889, 1906; Hancock, Mulberry Gap 1906, Sneedville 1906; Hawkins, Rogersville 1906; Jackson 1872, 1906; Johnson, Mountain City 1906; Loudon 1906; Macon 1889, Lafayette 1906; Marion, Sequatchie 1906; Morgan, 1889, 1906; Overton 1889, 1906; Pickett 1855, Byrdstown 1889, 1906; Polk 1906; Putnam, Cookeville 1906; Rhea, Dayton 1906, Lucknow 1889, Spring City 1906, Washington 1889, 1906; Roane, Harriman 1906, Kingston 1906, 1923, Oliver Springs 1906; Robertson, First Civil District 1906, Adams 1906, Barren Plain 1889, Cooperstown 1889, Greenbrier 1889; Scott, Oneida 1906; Smith 1889; Sullivan 1906; Sumner, Portland 1872, 1889, Sulphura 1855, 1872, 1889; Trousdale, Hartsville 1906; Unicoi, Erwin 1906; Union 1906; Van Buren 1838, 1855, 1872, 1889, 1906; Warren 1838, 1855, 1872, 1889, 1906; White, Fanchers Mills 1906, Quebeck 1906, Sparta 1906.

## Virginia.

Albemarle, Hickory Hill 1906; Arlington, Cherrydale 1923, Clarendon 1923, Rosslyn 1889; Augusta, Waynesboro 1906; Buchanan 1906; Dickenson, Clintwood 1872, 1889, 1906; Fairfax, Ash Grove 1906, Spring Hill 1923; Frederick 1906; Lee 1855, 1872, 1889, Dryden 1906, Jonesville 1906; Nelson, Faber 1872; Russell 1872; Tazewell 1889, 1906; Wise 1872, Big Stone Gap 1906, Stonega 1906.

## West Virginia.

Berkeley, Berkeley 1923, Falling Waters 1923, Glengary 1923, Hedgesville 1923, Jones Springs 1906, Martinsburg 1923, Shanghai 1906,

Tomahawk 1906; Boone, Comfort 1923, Gordon 1923, Hewett 1906, High Coal 1923, Lory 1923, Madison 1906, Morrisvale 1923, Rockbottom 1923; Brooke 1906; Cabell, Huntington 1889, 1906, 1923, Lesage 1923, Ona 1872, 1889, 1906, Salt Rock 1923; Doddridge 1906; Fayette 1906; Grant, Medley 1923; Greenbrier 1906; Hampshire, Bloomery 1889, 1923, Levels 1906; Hancock 1906; Hardy 1906, Perry 1923; Jackson 1906, Ravenswood 1906; Jefferson, Charles Town 1906, 1923, Harpers Ferry 1889, Kearneysville 1923; Kanawha 1838, 1855, 1889, Cabin Creek District 1906, Charleston 1906, 1923, Jefferson District 1906, London 1906, Malden 1906, Saint Albans 1923; Lincoln 1889, Branchland 1906, Bulger 1923, Griffithsville 1906, Hamlin 1889, Marigold 1923, Midkiff 1923, Myra 1923, Sheridan 1923; Logan, Logan 1889, Pecks Mill 1923, Verner 1923; McDowell, Bradshaw 1923, Brewsterdale 1923, Elkhorn 1923, Welch 1923, Yukon 1923; Mason, Beale 1906, Point Pleasant 1889; Mercer, Bluefield 1906, Spanishburg 1906; Mineral 1906; Mingo 1906; Monroe 1906; Morgan, Rock Gap 1906; Pendleton 1906; Pleasants, Belmont 1923; Pocahontas 1906, Buckeye 1923; Preston 1906; Putnam, Buffalo 1872, 1889, Poca 1889, Raymond City 1923, Scott Depot 1923, Waldo 1923, Winfield 1838, 1855, 1872, 1889; Raleigh 1906; Richie 1906; Roane 1906, Flatfork 1923; Wayne, Dunleith 1923, East Lynn 1923, Fort Gay 1923, Whites Creek 1906; Webster 1906; Wood, Washington 1906, Waverly 1906; Wyoming 1872, 1889, 1906, Pineville 1906, Uno 1923.





PERIODICAL CICADA (Magicalcaca septendecim (L.))

BROOD XIV





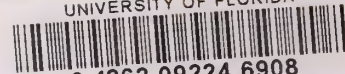


THE TRANSFORMATION OF THE EMERGED PERIODICAL CICADA.

1.-Pupa ready for transformation. 2.-Adult beginning to issue from pupal shell. 3.-Adult nearly free from pupal shell. 4.-Freshly transformed adult, the coloring immature. 5.-Adult, several hours after transformation, the coloring mature. About natural size.



UNIVERSITY OF FLORIDA



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